② AMATEUR SATELLITE REPORT

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*AMSAT's Newsletter for the Amateur Space Program.*

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## *UO-11: Early Glitch Thought Not Serious*

A problem with a cold 2 meter oscillator has put a temporary chill on the exuberance of a perfect launch of UoSAT-B into orbit March 1. University of Surrey scientist Martin Sweeting, G3YJO, said in a progress report, however, that several lines of approach are available to UoSAT program officials. A note of optimism was sounded when evidence supporting the theorized nature of the glitch surfaced.

The launch from Vandenberg Air Force Base on the California coast was letter perfect. At precisely 17:59 UTC, Thursday, March 1, the sleek Delta 3920 rocket lifted into the azure California sky trailing a plume of white, whispy exhaust trail. Aboard were the primary payload, Landsat D' (D-prime) and the secondary payload, UoSAT B.

UoSAT separated from the launcher while over Turkey at 19:11 UTC, 72 minutes into the mission. According to Program Manager G3YJO, the satellite was then in view of the command station at the University of Surrey, Guildford, England. "A lengthy series of instructions was transmitted to the spacecraft to establish the initial operating conditions," reported G3YJO. The beacon was then switched on for 10 seconds to check the housekeeping telemetry. The first sequence was kept short so as to reduce the potential of corona discharge if outgassing were incomplete at that stage.

The beacon was commanded on during orbit #2 and later on 3 as well. A shock came to the Surrey team which was just starting to relax when WA3ZIA in Ottawa and KA9Q in New Jersey reported that nothing was being heard on the 2 meter beacon when it should have been on. "The UoS Command Team were 'revived' and awaited the first pass of the day, #8", reported G3YJO. Later they found that the premature shut-down of the 2 meter beacon was due to software. Says Martin, "The timing clock selected had been running at 8 times that required." After some analysis it was determined tha the last observed telemetry was received by VK5AGR at about 23:00 UTC, 1 March. VK5AGR reported all was well with the telemetry at LOS. Piecing together the observations, the data seemed to support the clock selection theory as the culprit.

But now a new and potentially more serious malfunction manifested.

Despite numerous attempts, Surrey was unable to command the 2 meter beacon on again. Fears of catastrophic failure gave way to reasoning out a failure mechanism. According to G3YJO, a malfunction with the 2 meter beacon occurred during thermal vacuum testing. Then, the beacon was found to represent too large a load for the current limiter on the power distribution system. The fix implemented at that time was to increase the current "foldback" threshold so the oscillator would "cold-start". The present theory holds that the cold-start problem has recurred.

This hypothesis is at least partially testable. Martin theorized that "If the 145 MHz beacon is on but not operating correctly, it should be possible to observe it with high gain antennas and spectrum analyzers." Moreover, if the 2 meter beacon is producing "hash", a noise-like spectrum of broadband, low spectral intensity, that could explain the inability to effect commands. the hash would be deafening both on the 2 meter and 70 cm command receivers.

Fortunately, there is an additional command receiver on UO-11 that distinguishes it from UO-9 which had one each on 2 meters and 70 cm. UO-11 has a 24 cm command receiver that, it is hoped, will be largely unaffected by the 2 meter beacon generated hash, if that be the case in fact.

Early substantiation of the "hash" theory came when a number of stations reported sightings of an extremely weak signal, with Doppler shift, on 145.825 MHz at the times and locations where UO-11 was expected. W4DAQ in Demopolis, Alabama called *ASR* on 3 March with an observation report. Later VK5AGR relayed the report of an observation made by VK1DF. The latter, using a 26-meter dish at the Orroral Valley Tracking Station near Canberra, reported several observations made on 4 and 5 March. The levels were feeble indeed varying from – 120 dBm to – 135 dBm. Significantly, Darryl, VK1DF, reported that the signals were raspy; exactly what one would expect from a current-starved oscillator.

Other reports continued to filter in from around the world. These were checked against expected AOS-LOS times in hopes of verifying the observation report. NK6K issued an appeal for reports of reception of the feeble UO-11 2 meter beacon "hash" as he put it, since it might be one of the all-time great "T-Hunts"! (UoSAT and hounds!)

Meanwhile, attempts to command using the 1.2 GHz

uplink have commenced. A command encoder was air-lifted from London to Los Angeles where Chip Angle, N6CA, with the help of Harold Price, NK6K, will attempt to shut off the 2 meter oscillator. These attempts were continuing at press time.

Should the command on 24 cm prove unsuccessful, however, another feature of UO-11 is incorporated which distinguishes it from UO-9 and which, we are assured, precludes recurrance of the frustrating dilemma which temporarily debilitated UO-9. UO-9 wound up with 2 meter and 70 cm beacons simultaneously on and no practical way to overcome the strong local signal which served to QRM both the 2 meter and 70 cm command receivers. It took the thoroughly impractical multi-megawatt blast from a 150 foot (43 meter) radio telescope dish at SRI International in California to break the deadly loop on 20 Sept. 82 (See *ASR* #42, 22 Sept. 82). UO-11 has two safeguards to insure non-replication. First is the 24 cm command receiver which was mentioned above. Second, and significantly, it has a so-called "watchdog timer" which is programmed to turn off the beacons if no commands are heard for 20 days. This feature automatically breaks the loop in which UO-11 now exists. All are hoping this therapy will work if the command efforts by N6CA should fail to do the trick.

At press time most AMSAT officials were optimistic that UO-11 will be restored to its mission plan after this detour. On a distinct upbeat note, AMSAT officials were hailing the attainment of a successful launch with UO-11 as one of the great achievements in all of amateur radio history. They point out that beating the schedule seemed impossible to many when G3YJO and a team of AMSAT PACSAT individuals set out to build a spacecraft only last autumn. Many thought it impossible if a completed spacecraft were to enter *Testing* at that point. Nevertheless, the spacecraft was built, tested qualified and launched in record time. *this*, we are told by AMSAT, is *the* major story of UoSAT B: it made it to the pad on time, working and ready in all respects. And *that* will be what is remembered of UO-11 long after the recollections of the present glitch have faded.

## Dayton Hamvention Preparations In High Gear

The largest convention of its kind is rapidly approaching. Wray Dudley, W8GQW, reminds everyone that the weekend of 27, 28 and 29 April should be circled on your calendar. It is then that the mammoth event which is the Dayton Hamvention will be on-line.

The Hamvention is always an important event in AMSAT's calendar too! AMSAT will be there with the largest contingent of any event throughout the year. The AMSAT booth is always busy and well-staffed with experts and friends to answer your questions; exchange views. And of course it's time to renew old friendships and make new ones as well.

AMSAT forums have been arranged for each of the three days. AMSAT officials will give presentations on a variety of subjects of great interest to all members and to participate in discussion periods. A special guest will be ZS6AKV, Hans, President of AMSAT SA. Hans is preparing talks on the balloon experiments performed by AMSAT SA and also on satellite operation for the beginner.

W8GQW lives in Troy, Ohio, not far from Dayton. Wray, along with K8OCL and W8JLE plays a key role in preparing for AMSAT's participation in this fantastic event, the Dayton Hamvention. Plan now to be among the hundreds of AMSAT members on hand. It won't be the same without *YOU*!

## Short Bursts

• New Area Coordinator (Southern Ohio) Richard Burgraf, W8PGP is off and running. Dick gave a talk to the Instrument Society of America on 21 February. His talk was entitled "Design, Construction, Testing and Evaluation of Radio Amateur Communications Satellites."

• A series of 5 video tapes made at the Space Symposium/Annual Meeting will soon be available through the AMSAT Videotape Library. The tapes include all the major speakers and topics covered including AO-10, locator systems, Packet Radio, antennas and more. The tapes were recorded by W3TMZ, W3XO and the staff of the Applied Physics Laboratory where the meetings were held last November. AK3E volunteered to edit the tapes and he has done a fine job indeed according to W3TMZ. *ASR* will announce tape availability and procedures for borrowing the tapes from the library which is managed by WBØGAI, Roger, in Greeley, Colorado.

• W8DX reports a two-way SSTV QSO on AO-10 with F1BL. Other SSTV activity has been observed as well.

• KA6M reports a significant advance in packet communications. On 11 March, on orbit 560 the first teleport-type operations took place on AO-10. Here several stations communicated over AO-10 using packet radio techniques. WAØOJS/6 in Monterey, CA hooked up with W3IWI near Washington D.C. using KA6M as a teleport (terrestrial-to-space relay) station. WAØOJS was not aware that he was being trunked through AO-10. The transmissions were error-free over the satellite link according to KA6M. KA6M maintains a system of packet repeaters in Northern California. KA6M says "This is probably the first all digital interlink experiment performed on the AMICON channel." AMICON is the AMSAT International Computer Network and it resides on AO-10 SSC L1, 145.830 MHz. Participating in the experiment on 11 March were W3IWI, NK6K, AI8A/6, WAØOJS/6 and KA6M.

## New Area Coordinators Announced

Chief Area Coordinator WØCY announces the appointment of the following new area coordinators:

New York City (and environs)
Roger Soderman, KW2U

New Mexico
J.D. Miller, WA5WHN

Oregon
David Barnard, W7LSV

AMSAT congratulates these newest team members. Welcome aboard! Additional Area Coordinators are sought. Contacy WØCY, 1404 S. 10th St., Salina, KS 67401 or call (913) 827-2927.

## *Patches to Programs Offerred*

N5AHD and N3AR have provided *ASR* with some minor fixes for two popular versions of the W3IWI orbital prediction program. We print them below.

From N5AHD for the IBM-PC version, Bob says to make the following change:

Modify line 900 to read: 900 IF MONTH >2 THEN D8 = D8 + F9

From N3AR for the VIC-20 ajd Commodore 64 (AMS-2064), Ron says to make the following changes to allow the program to properly process negative drag factors:

Add lines:

2625 SP$=“”:IFA(J)<0THENSP$=“ ”

2915 SP$=“”:IFA(J-8)<0THENSP$=“ ”

Change lines 2630 and 2920 to read as follows:

2630 RW=J+5:CL=0:GOSUB5800:PRINTE$(J); “ ”;SP$;A(J)

2920 RW=J−4:CL=0:GOSUB5800:PRINTE$(J);“ ”;SP$;A(J-8)

The fix in the last two lines added SP$

Also, Ron advises that a value in line 6560 should be corrected as follows: change .27960663 to .27460663.

## *New UoSAT Systems Overview*

### Mechanical Framework

The spacecraft is constructed in a similar way to OSCAR 9. It has a square-section central core supporting rigid top and bottom plates. Solar cells are mounted on all four sides of these plates, enclosing a basic cuboid of dimension 35.5 X 35.5 X 58.5 cm. Two stacks, each of two module boxes of dimension 23.5 X 17.6 X 3.1 cm, are mounted on the outside of each face of the central core. A ‘wing’ extends the base of the spacecraft symmetrically by 16 cm on each side in one axis to permit the mounting of two SHF helical antennas, one on each side of the launcher attach fitting which is itself mounted in the center of the bottom plate. The Navigation Magnetometer and Space Dust experiments are mounted above this wing, one on each side.

### Solar Cells

Four solar arrays of dimension 49.5 X 29.5 cm are attached to the four sides of the spacecraft. These are capable of supplying up to about 0.9A at 28V when fully illuminated. The cells were manufactured by Solarex.

### Battery

A solid octagonal block of aluminum, 14.9 X 14.9 X 10.2 cm, is fitted into the center core of the spacecraft and is drilled to accept ten ‘F’-sized Nickel-Cadmium cells, each 3.2 cm in diameter and 9 cm long. These cells, in series, form a 12V battery of 6.4Ah nominal capacity and are charged when the spacecraft is in sunlight in order to provide sufficient power to run the craft during peak load demands and its eclipse periods.

### Battery Charge Regulator

Two redundant BCRs are responsible for accepting the 28V supplies from the solar cells (and a similar supply from the umbilical connector) and charging the battery as required depending on the current drain, the battery voltage and the battery temperature.

### Power Conditioning Module

The PCM regulates the 12-14V battery bus supply to provide 10V, 5V and −10V supplies for powering the spacecraft systems and experiments.

### Power Distribution Module (PDM)

The PDM switches the various regulated and unregulated rails to all the s/c systems and experiments, dependent on the commands which it receives from the Telecommand system. Each switch has an individual current foldback facility so that a faulty module is allowed to draw up to a predetermined current before it is latched off, necessitating a power-down under positive command before resetting.

### Telecommand System

The telecommand system comprises three uplink receivers, three data demodulators, a command detector and sets of command latches which hold the status of the command specified. The receivers are located in the 144 MHz, 438 MHz and 1268 MHz amateur bands and the demodulators are robust devices which do not depend on phase-locked loops or other potentially unstable techniques. A command detector scans the three receivers according to a priority system and detects a valid set of command instructions, passing the data contained therein to the relevant latch. Some latches drive a set of multiplexer address inputs directly so that uplink and downlink path selection may be performed immediately on the command latch board.

The 112 command latches drive the Power Distribution System, the remaining spacecraft systems and experiment functions. There is a parallel I/O port to the spacecraft 1802 computer for autonomous control of spaceraft operations in addition to serial data links with the 1802 computer and the DCE for backup operations.

### 145.825 MHz Beacon

The 145 MHz beacon on UoSAT-B is nearly identical to the one flown most successfully on UoSAT-1. The modulation index has been increased in order to ensure better reception on most radio amateur receivers. Modulation is by frequency shift keying, as on UoSAT-1.

### 435.025 MHz Beacon

This beacon is a completely new design which generates its frequency standard from a phase-locked synthesizer system. As a result, the dc to rf efficiency is much improved. In addition to frequency shift modulation, phase shift moduation is a switchable option.

### 2401.5 MHz Beacon

When the original supplier of the 2.4 GHz beacon was unable to meet his commitment, Colin Smithers, G4CWH,

at the University of Surrey stepped in and designed and built the transmitter and power supply in less than four weeks. The dc to rf efficiency has been improved by some 5 times over UoSAT-1 implementation. Both AFSK and PSK modulation methods are possible.

### Telemetry System

The basic output of the UoSAT-B telemetry system is very similar to that of UoSAT-1. However, 60 analogue channels, digitized to 3 decimal digits and 96 status points encoded into hexadecimal digits are available together with a real-time clock for frame identification and the satellite identifier, 'UoSAT-2'. A checksum digit can also be added to each channel. A dwell facility has been added so that up to 128 channels can be output in rotation, combined with clock times and line feeds or frame ends in any combination.

### 1802 Computer & Digitalker

The 1802 computer has been designed to support all the modules on the spacecraft, as well as to control the overall scheduling and be usable for specific communications experiments. To satisfy these requirements, the computer has access to many modules via parallel interfaces. It accesses some of the other modules as well as the receivers and transmitters via serial connections. In addition, there is a real-time clock and a total of 48kb of RAM for data storage. The Digitalker speech synthesizer is housed with the 1802 and has ROMs containing over 550 words. These will be used initally for 'speaking' telemetry.

### Navigation Magnetometer

The Navigation Magnetometer is a three-axis flux gate device, much upgraded from the one flown on UoSAT-1. Indeed, the 14-bit resolution is very similar to that obtained from the much more complicated scientific magnetometer on the previous craft. The Nav. Mag. will be used for determining the attitude of the spacecraft during initial maneuvers, as well as for experimental measurement of magnetic field disturbances once the attitude is stable.

### DSR Experiment

The DSR stores data from the CCD imager, particle counter experiment or computer UART and outputs it in a checksummed format. The unit has 2 banks of 96k X 8 CMOS memory which can be used as two separate banks or as one 192kb bank. The output frame consists of a three byte sync code, a two byte frame address, 128 bytes of data and 5 bytes of error detection/correction code. The data is sent in serial form with start bit, 8 data bits and selectable 1 or 3 stop bits. The data can be output at 1200, 2400, 4800 and 9600 bps.

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```
Satellite: oscar-9
Catalog number: 12888
Epoch time:      84059.37579141
   Tue Feb 28 09:01:08.377 1984 UTC
Element set:     589
Inclination:       97.5794 deg
RA of node:        32.4183 deg
Eccentricity:    0.0004812
Arg of perigee:   120.6543 deg
Mean anomaly:     239.5299 deg
Mean motion:   15.24558043 rev/day
Decay rate:      6.413e-05 rev/day^2
Epoch rev:           13280
Semi major axis:  6867.216 km
Anom period:     94.453603 min
Apogee:            507.926 km
Perigee:           501.317 km
Beacon:           145.8250 mhz
```

```
Satellite: oscar-10
Catalog number: 14129
Epoch time:      84063.83285908
   Sat Mar  3 19:59:19.24  1984 UTC
Element set:     90
Inclination:       25.6632 deg
RA of node:       212.1030 deg
Eccentricity:    0.6091272
Arg of perigee:   250.9131 deg
Mean anomaly:      36.7286 deg
Mean motion:    2.05853435 rev/day
Decay rate:       -2.8e-07 rev/day^2
Epoch rev:             544
Semi major axis: 26105.808 km
Anom period:    699.526826 min
Apogee:          35633.003 km
Perigee:          3829.487 km
Beacon:           145.8100 mhz
```

```
Satellite: oscar-11
Catalog number: 14781
Epoch time:      84067.40409430
   Wed Mar  7 09:41:53.747 1984 UTC
Element set:     MH 3-11-84mod
Inclination:       98.2510 deg
RA of node:       129.8480 deg
Eccentricity:    0.0006061
Arg of perigee:   243.8620 deg
Mean anomaly:     116.1950 deg
Mean motion:   14.61903052 rev/day
Decay rate:       4.76e-06 rev/day^2
Epoch rev:              83
Semi major axis:  7062.253 km
Anom period:     98.501744 min
Apogee:            705.268 km
Perigee:           696.708 km
Beacon:           145.8250 mhz
```

```
oscar-9:
Mon Mar 12 01:01:21.499 1984 UTC: Ascending node at 140.0 west
Nodal period: 94.50379 min
Longitude increment: 23.624167 deg w/orbit
Element set 589, epoch: Tue Feb 28 09:01:08.377 1984 UTC
```

```
oscar-11:
Mon Mar 12 01:23:59.23  1984 UTC: Ascending node at 56.4 west
Nodal period: 98.55997 min
Longitude increment: 24.639067 deg w/orbit
Element set MH 3-11-84mod, epoch: Wed Mar  7 09:41:53.747 1984 UTC
```

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